Broadcasting at low seed rate as performance technology for newly selected rice genotypes under wet direct seeding

Broadcasting is an attractive crop establishment technique in rice fields for its simple and fast operation, low labor cost, and short turnaround time between crops because of the absence of seedbed. Previous research showed that plants broadcast in irrigated paddy fields had higher grain yield than transplanted ones (San-oh et al, 2004). In direct seeding, however, land leveling is critical, weeds are problems, and seeding rate is high. At present, with the high demand for improved production at low cost, there is an urgent need to identify appropriate rice genotypes with low seed rate requirement under broadcasting and to adapt crop management to approach yield potential.

MATERIALS AND METHODS

Two field experiments, in IRRI and in Philrice, during dry season 2004 were set-up analyzing the performance of four genotypes: 2 hybrids–IR75217H (H1) and SL-8 (H3), 1 indica–IR72 (I1), and 1 new plant type–IR71676-90-2-2 (N1) under two seed rates (25 and 50 kg ha^{-1} for hybrids, 50 and 100 kg ha^{-1} for I1 and N1) under wet surface broadcasting (SB25, SB50 and SB100) and row seeding (SR25, SR50 and SR100) and only 50 kg ha^{-1} under hill sowing (HS50). In Philrice a transplanting check at 37.5 kg ha^{-1} (TP37.5) was included. Broadcasting dates were Jan. 12 and Jan. 15 for IRRI and Philrice, respectively. Transplanting was done on Jan 22.

Figure 1. Leaf orientation and canopy cover of H3 plants under SB50, SR50 and HS50 at 30 days after sowing at IRRI farm.

RESULTS

1. At the two test locations, H3 grain yield under SB25 was comparable with that under SB50 and both were higher than when row seeded, (by 14% and 9% in IRRI and in Philrice, respectively), hill-sown or transplanted (Table 1):
   - greater production of tillers, shoot dry weight per m^2 and leaf area index was observed under SB50 than SR50, HS50 and TP37.5 during the cropping period (Fig. 2; Fig. 3)
   - greater number of productive tillers at maturity under SB25 and SB50 was mostly the reason for higher grain yield even if some compensation was noted with filled grain number per productive tiller and SSL (stem length/stem dry weight). Harvest index and tiller senescence ratio were similar among treatments (Table 1).
2. H1 produced similar grain yield in all the seeding methods in both locations (Table 1).
3. In IRRI for I1 and N1 grain yield was higher at most by 16% and 13%, respectively, under SB50 than the other seeding methods mostly due to higher number of productive tillers (Table1). In Philrice, the grain yield performances of I1 and N1 were similar under all direct seeding and better than or similar to those in TP37.5 (Table 1).

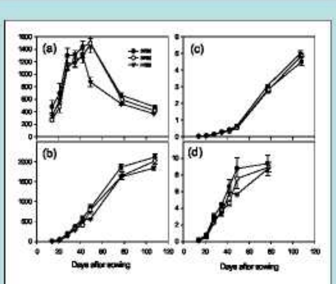

Figure 2. Development of H3 with days after sowing (a) productive tiller no per m^2 (b) shoot dry weight (g/m^2) (c) shoot dry weight per productive tiller (d) leaf area index (cm^2/cm^2), IRRI, DS 2004

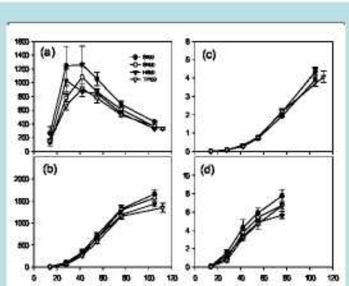

Figure 3. Development of H3 with days after sowing (a) productive tiller no per m^2 (b) shoot dry weight (g/m^2) (c) shoot dry weight per productive tiller (d) leaf area index (cm^2/cm^2), Philrice, DS 2004

Table 1. Grain yield and yield components from IRRI and grain yield from Philrice, dry season 2004.

ESTABLISH-MENT	ShDW[a] (g/m^2)	PtilNB (no/m^2)	FGrNB (no/PT)	HI (cm^2/cm^2)	SSL (cm/g)	TSR	GY^{IRRI} (t/ha)	$GY^{Philrice}$ (t/ha)
H3[b]								
SB25	2212a †	446ab	83.5ab	0.475a	46.26ab	0.787a	9.77ab	9.15ab
SR25	2197a	389c	91.2a	0.450b	43.02b	0.755a	8.74c	8.23b
SB50	2111a	476a	78.5b	0.465ab	48.95a	0.695a	10.38a	9.24a
SR50	2018ab	414bc	82.5ab	0.462a	49.52a	0.722a	8.66c	8.13b
HS50	1840b	368c	84.0ab	0.467ab	48.26a	0.725a	9.12b	8.18b
TP37.5								8.28b
H1								
SB25	2181a	564ab	77.8ab	0.495a	62.40a	0.725a	9.16a	8.19a
SR25	1876c	470cd	81.0a	0.490a	62.33a	0.725a	9.56a	8.03a
SB50	2021b	583a	70.0b	0.470a	65.94a	0.690a	9.11a	7.63a
SR50	1878c	516bc	72.3ab	0.495a	63.58a	0.745a	8.93a	7.71a
HS50	1524d	418d	72.3ab	0.475a	62.06a	0.695a	8.45a	8.25a
TP37.5								8.57a
I1								
SB50	1951a	626ab	55.2a	0.432a	57.42a	0.690b	9.68a	6.72a
SR50	1849ab	576b	55.0a	0.420a	59.45a	0.730ab	8.55b	6.71ab
SB100	1948a	693a	44.0b	0.385b	62.25a	0.690b	8.90ab	6.85a
SR100	1828ab	600b	50.0ab	0.405ab	55.64a	0.732a	8.10b	6.73ab
HS50	1676b	522c	52.5a	0.407ab	55.73a	0.690b	8.94a	6.70ab
TP37.5								6.06b
N1								
SB50	2060a	678a	59.0a	0.465bc	65.50b	0.685bc	9.35a	7.56a
SR50	1673bc	615b	54.8b	0.475ab	71.04ab	0.710ab	8.64b	7.62a
SB100	1757b	682a	47.5c	0.460c	72.25ab	0.665c	8.74b	7.50a
SR100	1679bc	629b	50.5c	0.465bc	74.98a	0.722a	8.63b	7.60a
HS50	1586c	528c	60.0a	0.480a	65.70b	0.712ab	8.36b	7.32a
TP37.5								8.01a

[a] ShDW stands for shoot dry weight, PtilNB for productive tiller number, FGrNB for filled grain number per productive tiller, HI for harvest index, SSL for specific stem length, TSR for tiller senescence ratio, and GY for grain yield.
[b] H3, H1, I1 and N1 refers to SL-8, IR75217H, IR72 and IR71676-90-2-2, respectively.
† In a column means followed by different letters are significantly different at the 5% level by LSD test (n=4).

4. The highest shoot dry weight per m^2, and the highest grain yield was observed for the genotype (H3) with the lowest productive tiller number but with the most vigorous tillers (highest panicle dry weight and lowest SSL).

Table 2. Comparison of grain yield and yield components of the four genotypes tested under SB50, IRRI and Philrice, dry season 2004.

VARIETY	ShDW (g/m^2)	PtilNB (no/m^2)	ShDW (g/productive tiller)	PaDW[a] (g/productive tiller)	FIGrDW (g/productive tiller)	FIGrNB (no/m^2)	SSL (cm/g)	GY-5m^2 (t/ha)
IRRI								
H3	2111a	476c	4.51a	2.35a†	2.10a	75.6a	49.0b	10.38a
H1	2021a	583b	3.49b	1.86b	1.64b	69.9ab	65.9a	9.11b
I1	1951a	626b	3.13c	1.46c	1.36c	52.2c	57.4ab	9.68ab
N1	2060a	678a	3.05c	1.53c	1.42c	59.0bc	65.5a	9.35b
Philrice								
H3	1659a	429b	3.29a	2.10a	1.95a	74.8a	59.3c	9.25a
H1	1494ab	492ab	3.09b	1.75a	1.60ab	68.3ab	70.6ab	7.62b
I1	1262b	476a	2.64b	1.29b	1.18c	51.5c	65.4bc	6.72b
N1	1482ab	574a	2.61b	1.36b	1.26bc	54.5bc	73.5a	7.15b

[a] PaDW stands for panicle dry weight; the rest was defined in the previous Table.
† In a column means followed by different letters are significantly different at the 5% level by LSD test (n=4).

DISCUSSIONS

Seed broadcast allowed for greater production of leaves, tillers and total shoot dry matter that consequently produced better grain yield. Tiller senescence ratio ((max. tiller no. - tiller no. at maturity)/max. tiller no.) did not consistently affect grain yield of all the genotypes tested in contrast with what was considered when NPT was designed. H3 and H1 broadcast at 25 kg ha^{-1} had equal yield as 50 kg ha^{-1} whereas I1 and N1 at 50 kg ha^{-1} had better or equal yield to 100 kg ha^{-1} that were all greater than or equal the yield under transplanting. The San-oh et. al. (2004) also observed higher grain yield under broadcast due to greater weight of dry matter compared to transplanted which they attributed to rapid increase in leaf area index and larger interception of solar radiation from more erect leaves of plants in direct-sown. Erect leaf orientation was also observed under broadcast in the present study (Fig. 1). Further studies on spatial leaf orientation shall be performed. Seed broadcast was the simplest, fastest and least labor consuming among methods studied and at low seed rate can be a good establishment for either inbred, hybrid or new plant type.

REFERENCE

San-oh, Y., Mano, Y., Ookawa, T., and Hirasawa, T., 2004. Comparison of dry matter production associated characteristics between direct-sown and transplated rice plants in a submerged paddy fiels and relationships to planting patterns. Field Crop Research 87, 43-58.

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